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DOT MATRIX LINE PRINTER
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SPECIFICATION

1. Title

Dot Matrix Line Printer

2. Claims

A dot matrix line printer that prints images by sweeping back and forth a plurality of hammers in sync with one another in the direction vertical to the paper-feed direction, wherein a plurality of dot-printing mechanisms are arranged in a row at equal intervals in the sweeping direction, their hammers being positioned in a staggered arrangement in the paper-feed direction with a positional difference corresponding to two dots, and wherein printing is effected by shuttling back and forth these dot-printing mechanisms sideways with an angle and a distance that are defined by a half-dot pitch in the sweeping direction and a one-dot pitch in the paper-feed direction and, at the same time, by sweeping the mechanisms as a whole back and forth in the direction vertical to the paper-feed direction.

3. Detailed Description of the Invention

The present invention pertains to a dot matrix printer. More specifically, it pertains to a high-speed dot matrix line printer that prints images with a plurality of hammers that shuttle in sync with one another in the direction vertical to the paper-feed direction, that is, in a transverse direction.

A widely adopted method of printing for this type of dot matrix line printer has been a method that forms printouts by synchronizing a plurality of dot-printing mechanisms having hammers and being positioned at equal intervals and by sweeping them in a reciprocating manner from side to side, and, at the same time, by operating the paper-feed mechanism in incremental steps of a dot pitch in sync with this sweeping movement. The following explains this conventional method in further detail, referring to Fig. 1. Sixty-eight dot-printing mechanisms (1) (H_1, H_2, ... H_{68}) have a hammer (2) (N_1, N_2, ... N_{68}) at the tip of each mechanism, and each dot-printing mechanism (H_1, H_2, ... H_{68}) is mounted on the same carriage (3) at equal intervals. The carriage is pressed against the eccentric cam (5) illustrated on the left side of the figure by the elasticity of the spring (4), and, as the eccentric cam (5) rotates eccentrically about the shaft (6), the carriage (3) sweeps from side to side in a reciprocating manner. Along with the sweeping movement of the carriage (3), a plurality of hammers (N_1, N_2, ... N_{68}) move simultaneously. Referring to Fig. 1, the following explains the relationship between each hammer and the printing operation. The first hammer (N_1) is in charge of printing the first and second characters; N_2 is in charge of printing the third and fourth characters; similarly for the rest, the n-th hammer (N_n) is in charge of printing the (2n-1)th and 2n-th characters; and, finally, N_{68} is in charge of printing the 135th

character and 136th character. When N_1 is initially located at position P_1' and prints dot A_1 of the first character, N_2 is located at position P_2' and prints dot A_2 of the third character. When N_1 reaches position P_1 as the carriage (3) moves to the right, said N_1 prints dot B_1 of the second character, and N_2 prints dot B_2 of the fourth character. While this takes place, the sheet (20) is still, but, when N_1 completes printing dot B_1, the sheet (20) is transferred by one dot by a paper-feed mechanism, and, as a result, N_1 moves from the B_1 dot position to the C_1 dot position, and, similarly, N_2 moves from the B_2 dot position to the C_2 dot position, at which point the paper stops. Next, the carriage (3) starts moving toward the left, and the printing position moves from the C_1 dot position to the D_1 dot position and, similarly, from the C_2 dot position to the D_2 dot position. After the carriage has moved to the D_1 dot position, the sheet is stepped again, which brings the hammers from the D_1 dot position to the E_1 dot position and, similarly, from the D_2 dot position to the E_2 dot position. By repeating this operation, dot matrix characters are formed. In other words, the sweeping of the hammers and the feeding of the sheet are repeated several times alternately in sync with each other, thereby completing the printing of one line comprised of the first to 136th characters.

As is evident from the aforesaid explanation, in order to complete the printing of one line when the characters in the line have,

for example, a 22 x 22-dot structure, it takes 22 sweeping motions and 21 minute-paper-feed movements. This type of configuration does not pose any problem when the printing speed is slow, but it presents the following problems in high-speed printing. That is, there is the problem of constraint on the sweeping frequency of the aforesaid carriage. In the case of performing high-speed printing at a speed of, for example, 240 lines per minute, the frequency of the carriage becomes 44 hertz or higher. As mentioned before, a large number of dot-printing mechanisms are mounted on the carriage, and the weight of the carriage becomes considerably heavy, which may reach several kilograms; therefore, it is not easy to drive this structure at 44 Hz, and, if this is carried out forcibly, it presents the problem of an excessively large driving load and of large vibration and noise.

In addition, because the conventional dot matrix line printer requires minute-step, high-speed paper feeding after one dot line is printed, in the case of carrying out high-speed printing, the printing of the subsequent line is carried out before the vibration of the sheet caused by the paper feeding settles down, thus presenting the problem of substantial deterioration of printing quality.

As explained in the foregoing, the conventional high-speed dot matrix line printer has a serious shortcoming in that the problem of constraint on the sweeping frequency and the printing-quality problem caused by the minute-step, high-speed feeding of printing paper put a

constraint on an attempt to improve the high-speed performance of the printer, limiting the speed at 100 lines per minute for practical purposes and making it difficult to realize a high-speed operation at a speed higher than that.

The object of the present invention is to solve the aforesaid shortcomings of the conventional high-speed dot matrix line printer by substantially reducing the sweeping frequency of the carriage that holds dot-printing mechanisms and by reducing the number of paper-feed operations required to print one line, thereby increasing the capability of the conventional high-speed operation by several degrees and providing a high-speed dot matrix line printer with a considerably improved high-speed performance.

In the dot matrix line printer of the present invention, a plurality of dot-printing mechanisms are arranged in a row at equal intervals in the sweeping direction, which is vertical to the paper-feed direction, and the hammers held by the aforesaid dot-printing mechanisms are positioned in a staggered arrangement in the paper-feed direction with a positional difference corresponding to two dots, said printer printing images by shuttling these dot-printing mechanisms back and forth with an angle and a distance that are defined by a one-dot [sic] pitch in the sweeping direction and a one-dot pitch in the paper-feed direction and, at the same time, by sweeping the mechanisms back and forth in the direction vertical to the paper-feed direction.

The following explains the present invention by presenting an embodiment, referring to figures.

Fig. 2 is a schematic frontal view of the high-speed dot matrix line printer pertaining to one embodiment of the present invention. In the illustrated embodiment, twelve printing mechanism assemblies (7) comprised of U_1, U_2, ..., U_{12} are mounted on the sub-carriage (8) at equal intervals. This sub-carriage (8) is connected to the main carriage (11) in such a manner that, by means of a pair of eccentric cams (9, 10), the sub-carriage can make reciprocating movements with a sideway angle (indicated by arrow A in the figure) and a distance that are defined by a one-dot pitch in the paper-feed direction and a half-dot pitch in the direction vertical to the paper-feed direction. The main carriage (11), like the structure of the prior-art example shown in Fig. 1, is pressed against the eccentric cam (12) located on one end by the elasticity of the spring (13). Each printing mechanism assembly (7), for example, U_1, is configured so that it has six dot-printing mechanisms (14) (H_1, H_2, ..., H_6) arranged in a row in the sweeping direction; so that the hammers (15), that is, P_1, P_2, ..., P_6, of H_1, H_2, ..., H_6 are positioned in an alternately staggered arrangement in the paper-feed direction with a positional difference corresponding to two dots; and so that the relative positions of hammers P_1, P_2, ..., P_6 in the U_1 printing mechanism assembly are exactly the same as the relative positions of hammers P_7, P_8, ..., P_{12},

P_{13}, P_{14}, ..., P_{18}, ..., P_{67}, P_{68}, ..., P_{72} of U_2, U_3, ..., U_{12}. The present invention is not limited to embodiments that use leaf-spring-type dot-printing mechanisms, as in the illustrated embodiment, and, of course, various other kinds of dot-printing mechanisms can be used.

Fig. 3 (a) is a drawing for explaining the printing operation of the present invention. Fig. 3 (b) is a drawing that shows in enlargement the operation illustrated in Fig. 3 (a). In these figures, in the case of printing characters having a 7 x 5-dot structure, hammer N_2 is initially located at position A_{31} and prints dot a_{31}. Here, hammer N_3 is positioned 2 dots away from N_2 in the paper-feed direction; therefore, hammer N_3 is located at position B_{11} in Fig. 3 (b) and prints dot b_{11} of the second character. Similarly, N_4 is located at position C_{31} and prints dot c_{31}. At this stage, N_1 is located out of the printing range and does not print. Next, the main carriage (11) moves a 1/2 dot pitch to the right, and, at the same time, the aforesaid sub-carriage (8) moves a 1/2 dot pitch to the left and one dot pitch downward in relation to the main carriage (11). As a result, hammer N_2 moves to position A_{41} and prints dot a_{41}, and, similarly, N_3 and N_4 print dot b_{21} and dot c_{41}, respectively. Subsequently, the aforesaid main carriage (11) moves a 1/2 dot pitch to the right again, but the sub-carriage (8) this time moves a 1/2 dot pitch to the left and one dot pitch upward in relation to the main carriage (11). As a result, hammer N_2 moves to position A_{32} and prints

dot a_{32}, and, similarly, N_3 and N_4 print dot b_{12} and dot c_{32}, respectively. In this manner, hammer N_2 prints dots a_{31}, a_{41}, a_{32}, a_{42}, a_{33}, a_{43}, a_{34}, a_{44}, a_{35}, and a_{45} sequentially and reaches position B_{31}. When this takes place, hammer N_1 is located at position A_{11} and prints dot a_{11} for the first time, and hammer N_2 prints dot b_{31} of the second character. When N_2 reaches position B_{45} and prints dot b_{45} in this manner, the sheet is fed upward by a 4-dot pitch. Then, the aforesaid main carriage (11) this time starts moving to the left, and hammer N_2 prints dots b_{75}, b_{74}, b_{73}, b_{72}, b_{71}, a_{75}, a_{74}, a_{73}, a_{72}, and a_{71} sequentially. Other hammers (N_3, N_4) also print in sync with and in the same manner as N_2, thereby forming a dot matrix.

This operation is repeated to effect printing, and what is noteworthy here is that, compared with the prior-art method illustrated in Fig. 1, which requires minute-step, high-speed paper feeding for every dot row, the number of paper-feed operations according to the present invention is reduced to 1/4; as a consequence, when compared with the prior-art sweeping-type dot matrix line printer, the present invention solves problems associated with paper-feeding and improves printing quality substantially.

Furthermore, when the sweeping frequency of the aforesaid main carriage is considered, the present invention makes it possible to print 4 dot rows while sweeping the main carriage in one direction; consequently, the present invention can realize a high-speed operation

that is four times faster than that of the prior-art sweeping-type dot matrix line printer.

In the present embodiment, the case of printing characters having a 7 x 5-dot structure is presented as an example, but the present invention functions especially effectively when high-density dot printing, such as the printing of a 24 x 24 dot structure, is required. In the aforesaid embodiment, the reciprocating movements of the aforesaid main carriage (11) and sub-carriage (8) are effected by eccentric cams, but it is possible to employ cams having a shape that makes it possible to effect uniform-velocity movements, cranks, linear motors, etc.

As explained in the foregoing, the present invention increases the maximum sweeping frequency along with the maximum printing speed and solves problems caused by minute-step, high-speed paper feeding, thereby making it possible to increase the speed of a high-speed dot matrix line printer.

4. Brief Explanation of the Drawings

Fig. 1 is a schematic frontal view for explaining an example of the printing operation of conventional dot matrix line printers. Fig. 2 is a schematic frontal view that illustrates an embodiment of the present invention. Figs. 3 (a) and (b) are drawings for explaining the printing operation of the embodiment of the present invention.

1, 14 ... dot-printing mechanism

2, 15 ... hammer

3 ... carriage

4, 13 ... spring

5, 9, 10, 12 ... eccentric cam

6 ... shaft

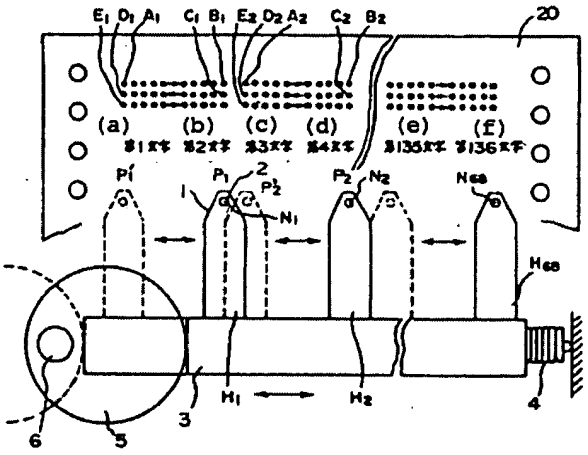
7 ... printing mechanism assembly

8 ... sub-carriage

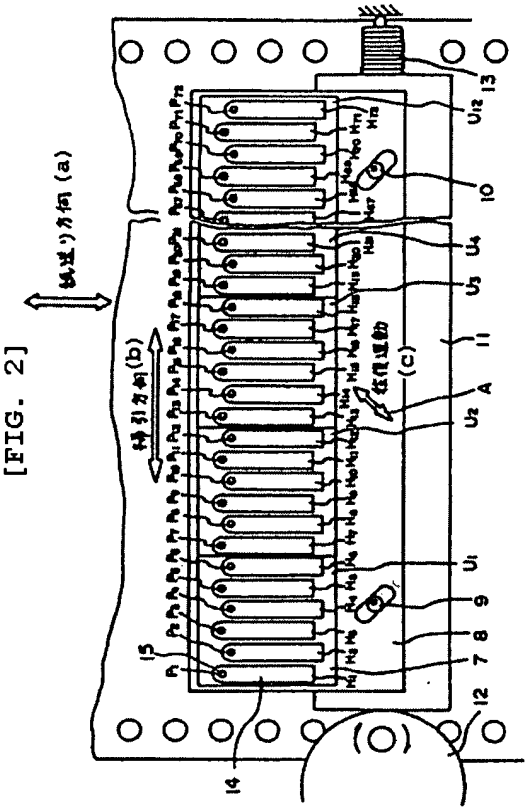
11 ... main carriage

20 ... paper

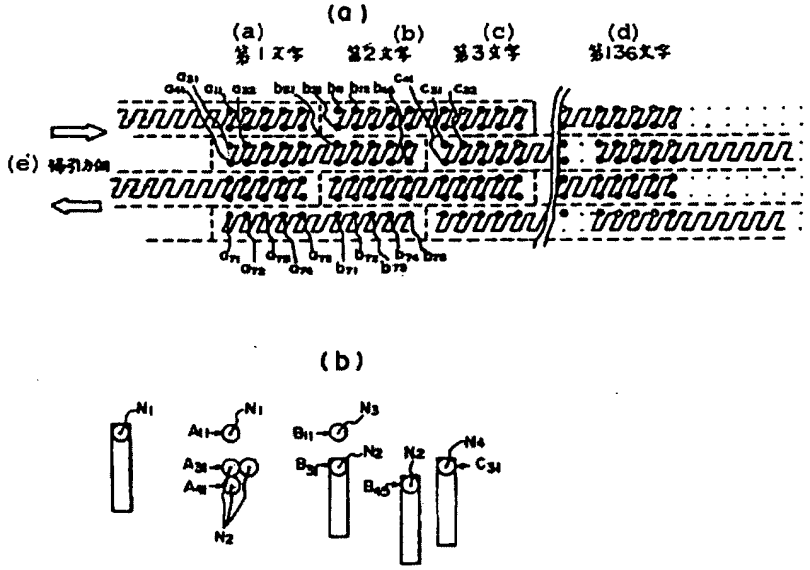
[FIG. 1]



[FIG. 2]



[FIG. 3]



[Fig. 1]
Key: a) first character; b) second character; c) third character; d) fourth character; e) 135th character; f) 136th character.

[Fig. 2]
Key: a) paper-feed direction; b) sweeping direction; c) reciprocating movement.

[Fig. 3]
Key: a) first character; b) second character; c) third character; d) 136th character; e) sweeping direction.